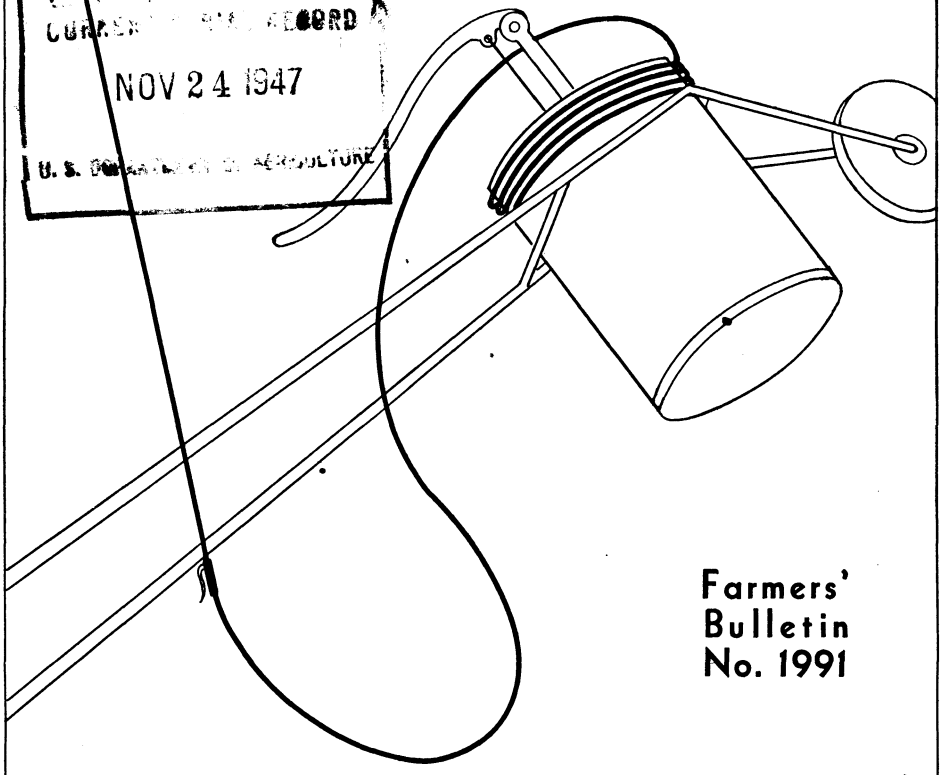
THE USE OF DISINFECTANTS on the FARM



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The word "infected" means contaminated with or affected by disease germs; "disinfected" means freed of disease germs. A "disinfectant" is a product that destroys disease germs or renders them harmless. An "antiseptic" is a substance that prevents the development and growth of disease germs but an antiseptic is not a disinfectant unless it is capable of destroying disease germs in addition to preventing their growth.

A disinfectant is not necessarily an "insecticide," for some powerful disinfectants are relatively harmless to insects, and good insecticides may be of little value as disinfectants.

Formaldehyde is a powerful disinfectant, but it is a very weak insecticide; and, conversely, hydrocyanic acid is deadly to insects and all forms of animal life, while it has little power as a germicide or disinfectant. It is well to remember also that "deodorants" are not necessarily disinfectants—one destroys odors, the other destroys germs.

No single disinfectant is appropriate in all cases. Select the proper substance, apply liberally, allow ample time for the disinfectant to do its work, and remember that success depends in large part upon the care and exactness of the person who prepares and applies the disinfectant.

This bulletin is a revision of and supersedes Farmers' Bulletins 926, Some Common Disinfectants, and 954. The Disinfection of Stables.

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THE USE OF DISINFECTANTS ON THE FARM

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Contents

NEED FOR DISINFECTANTS

THIS bulletin indicates briefly the properties and uses of some of the disinfectants that are commonly used about the household and the farm but does not attempt to cover the entire field.

There are two opposing forces in infection—the disease germ and the defensive force of the animal body. The ability of germs to invade depends primarily on the number present and their vigor. The healthy animal body is able to resist invasion by considerable numbers of germs, especially if the germs have lost most of their original vigor. On the other hand, an animal in poor condition is generally more susceptible to infection.

The essential sources of disease germs are the bodies of diseased animals. After leaving such animals, the germs die or tend to lose their vigor. Their survival outside the animal body is favored by the presence of manure and other waste matter—the substances included in the general term, "dirt."

The importance of cleanliness in the care of animals cannot be overemphasized. Proper cleaning removes most of the germs, along with the dirt that protects them, and the remaining germs are usually so weakened or so few in number that they are harmless under ordinary conditions.

If in addition to having clean surroundings the animals themselves are kept clean, well-fed, and in good condition, there is ordinarily

no need for the use of disinfectants. If disease breaks out, however, it will be necessary to make use of disinfectants as well as of the usual cleaning agents. Since the sick animal is the original source of infection, it should be kept away from the healthy animals, and since the number and vigor of disease germs are greatest near their source in the sick animal the best place to use disinfectants is in its immediate vicinity. The materials to be disinfected include manure, urine, and other body discharges, and bedding or other material soiled by such discharges. If infected material is scattered, it becomes necessary to apply disinfectants very extensively and thoroughly in order to be sure of reaching all of it.

The general principles discussed above are applicable to human beings. Sick persons should avoid contact with healthy persons, and utensils employed by sick persons should be kept separate from those used by other members of the family. Before being used by others such utensils should be thoroughly cleaned. Eating utensils, for example, should be cleaned with hot water and soap and then immersed in boiling water. After removal from the boiling water they may be allowed to dry without the usual drying with a dish towel.

In some instances—for example, in scabies—disease is caused by insectlike parasites which are very small but not microscopic in size. In combating such diseases the destruction of the causative organism is usually accomplished through total immersion of the infected animal in a solution that is poisonous to the parasite, but the dip as diluted is not dangerous to the animal. Such a process is called dipping, and the substance used for preparing the solution, or the solution itself, is called a dip.

In cattle-tick fever, formerly known as Texas fever, the causative organism is microscopic in size, but the disease is combated by destroying the tick that carries the micro-organism; hence in this case also dips are employed. A few chemicals or compounded mixtures may be useful for both dipping and disinfection, but there is no necessary relationship between dips and disinfectants because insects and ordinary disease germs are so different that a substance fatal to one may not be harmful to the other. Dips are therefore usually considered in a class by themselves, apart from disinfectants.

Disinfectants differ from one another in many of their properties, including their ability to kill micro-organisms, and germs also differ widely in their susceptibility to the various disinfectants. No single disinfectant is efficient against the germs of all diseases, nor is any disinfectant equally effective against the same germ under all conditions, for the activity of every disinfectant is influenced by such factors as the time of exposure to the disinfectant, temperature, chemical reaction and concentration, and the kind and amount of organic matter that may be present. Strictly speaking, there is no such thing as a "general disinfectant." So far as possible a disinfectant should be selected for its efficiency against the germs of a particular disease and its suitability for use in the place where it is to be applied.

GENERAL RULES FOR USING DISINFECTANTS

No matter what disinfectant may be chosen, however, there are certain general principles to be considered in using it. In the first place, since very few disinfectants act instantaneously even under the most

favorable circumstances, it is always necessary to allow them ample time. In the second place, temperature has a great effect on the activity of disinfectants. Cold decreases and heat increases activity, so disinfecting solutions should, if possible, be used warm, or even hot. Furthermore, under practical conditions on the farm, more or less dirt is always present, especially manure and other organic materials. Most disinfectants penetrate slowly and poorly, especially when organic matter is present. Solutions usually penetrate better than emulsions, and gaseous disinfectants cannot be depended on to penetrate to any depth. If manure or other similar material is to be disinfected, it must be broken up and thoroughly mixed with the disinfecting solutions so that the latter is distributed through the mass.

Since organic matter serves to protect disease germs and otherwise interferes with the activity of disinfectants, disinfection should always be preceded by thorough cleaning. All manure, bedding, and rubbish in stables or barnyards should be removed to a place inaccessible to livestock and burned, if possible, or thoroughly mixed with disinfectant. Then after the area has been cleaned with hot water and soap or washing soda, the disinfecting solution should be applied liberally and thoroughly. If only a small surface is to be disinfected, the solution may be applied with a whitewash brush. In all cases, however, the best method of application is by means of a spray pump.

PRINCIPAL DISINFECTING AGENTS AND SUBSTANCES

Only the most useful physical agents and chemical substances used to kill disease germs will be discussed here. Among the physical agencies are sunlight and heat. Direct sunlight is an active germicide, but its intensity is so variable and its disinfecting power so superficial that it cannot be considered a reliable disinfecting agent. Heat may be applied in various ways, as by flame or boiling water. The chemical substances include acids, alkalies, compounds of various metals, chlorine and iodine and their compounds, and the general group that includes alcohol, carbolic acid, and substances chemically related to them. Some of these, such as sulfur dioxide and formaldehyde, are used as gases. The rest are used in solutions, usually in water.

Various substances or compounds are sometimes recommended as disinfectants on account of their odor. But there is no connection between odor and disinfecting value, and disinfectants should be chosen only on account of their known disinfecting value.

Although none of the disinfecting agents or substances described in this bulletin are universally useful, some of the simplest and least expensive can usually be employed in place of expensive proprietary preparations. When they can be used, such simple processes as burning, baking, boiling, or steaming will usually be more effective than any chemical disinfectant. Except for disinfection against the germs of tuberculosis, lime and lye, which are cheap and readily available, will be found quite generally satisfactory.

HEAT IN VARIOUS FORMS

Burning is a most useful way of applying heat wherever circumstances permit. For example, if the place to be disinfected contains a great deal of rubbish and articles of little value, burning will often

be cheaper and easier than disinfection. Burning is also the most satisfactory method of disinfecting and disposing of small amounts of infected body discharges.

Dry heat is not so satisfactory as moist heat, since it lacks penetrating power and scorches fabrics, but it may occasionally be preferred. The ordinary household oven may be used for the purpose, and it should be heated sufficiently to brown cotton slightly (about 320° F.). Objects to be disinfected should remain in the oven at this temperature for at least 1 hour.

Moist heat is most often employed as boiling water or steam. Exposure to boiling water will destroy all ordinary disease germs, although it sometimes fails to kill the spores of such diseases as anthrax (splenic fever) or tetanus (lockjaw). Many disease germs are killed by moist heat at temperatures much below the boiling point of water as, for example, in the pasteurization of milk. Most of the ordinary disease germs are killed by boiling water in a very few moments. Boiling water may be used for the disinfection of fabrics of many kinds and of articles or implements made of materials that are not injured by boiling. In disinfecting objects made of iron or steel the addition of 1 percent of carbonate of soda to the water will prevent rusting. Although, as stated above, most of the ordinary disease germs are killed by boiling water very quickly, it is advisable in practice to allow at least 10 minutes' exposure so that every particle of the material to be disinfected may be heated to the required temperature.

Steam under pressure is perhaps the most effective of all disinfecting agents, but under farm conditions steam would usually be employed at atmospheric pressure as "streaming" steam. This has the same basic disinfecting power as boiling water, since streaming steam and boiling water have the same temperature—100° C. (212° F.). In practice, however, such steam requires a longer time to bring all of the material to be disinfected to the required temperature, and it is advisable, therefore, to allow an exposure of half an hour to an hour.

Steam is useful for the disinfection of many kinds of material, but it shrinks woolen fabrics and ruins leather, fur, skins of all kinds, rubber shoes, oilcloth, and articles containing glue or varnish. Disinfection with streaming steam does not require any apparatus except a boiler to supply the necessary steam and a hose or tube to carry it. Feed bags or other articles of similar material may be disinfected by being hung in any sort of small compartment and treated with steam. Such a structure need not be tight, for the steam escaping through the cracks serves to produce a circulation that aids penetration of the heat.

SULFUR DIOXIDE

Sulfur dioxide is the gas liberated by burning sulfur. Although commonly used in the past, it is little used now and is not recommended because it is too destructive to fabrics, colors, and metals. It is not a very good germicide and is more useful for the destruction of insects and vermin than for disinfection.

FORMALDEHYDE GAS

Formaldehyde gas is practically the only gas suitable for general use in disinfection. However, it is unstable and requires a certain temper-

ature and humidity to be effective. Like the other gases it cannot be depended upon for more than surface disinfection and unless it is very carefully used the results obtained are likely to be uncertain and unreliable. The two methods most generally used for applying formaldehyde gas are the spray method and the potassium permanganate method.

Spray Method

The spray method is best suited for use in small compartments, such as chests and closets. The commercial 40-percent solution of formaldehyde is used. This is sprayed directly into small chests and closets, and in the case of small rooms the solution is sprinkled upon a sheet which has been suspended in the room for the purpose. An ordinary sprinkling can, such as is used for watering flowers, may be used for spraying the solution of formaldehyde. At least 10 ounces of the solution should be used for each 1,000 cubic feet of space in the room. After the formaldehyde has been sprayed, the room or compartment should be quickly closed, keyholes and apertures sealed, and allowed to remain so for at least 8 hours. The attendant should take precautions to avoid contact with the spray as it is irritating to the eyes and nose.

Potassium Permanganate Method

The potassium permanganate method is used for disinfecting rooms and large compartments. It is carried out by pouring a 40-percent solution of formaldehyde upon crystallized or powdered potassium permanganate. Since some of the formalin is used up in the chemical reaction with the permanganate, it is necessary to use 20 ounces of formalin and 16⅔ ounces of potassium permanganate for the disinfection of 1,000 cubic feet of space.

The permanganate is placed in a wide-bottomed bucket or basin and the formalin poured over it. Since the reaction between the two substances liberates considerable heat, it is advisable to place the container on bricks or some other suitable material in order to prevent injury to the floor.

When the room is ready for disinfection with formaldehyde gas the container of permanganate should be placed on bricks and the requisite quantity of 40-percent formaldehyde poured upon it. The attendant should leave immediately and the room should be quickly closed and sealed. The room should not be reentered while gas is being liberated unless a suitable gas mask is used.

As the action of formaldehyde gas is superficial, objects or materials to be disinfected should be spread out so as to offer the greatest possible surface to the action of the formaldehyde. After the gas has been liberated, the room or compartment should be kept tightly closed for at least 8 hours before it is opened and aired.

Formaldehyde Solution (Formalin)

Formaldehyde solution (liquor formaldehydi U. S. P.) is commonly known by the trade name of formalin.

Solution of formaldehyde is a most excellent and reliable disinfectant. For general purposes it is best used by making a 10-percent

solution in water; that is, 10 parts of the 40-percent solution of formaldehyde made to 100 parts with water. Small objects which will not be injured by wetting may be immersed in the solution. It does not affect metals injuriously except after prolonged action. It is an excellent deodorant as well as a disinfectant and may be usefully employed for disinfecting small areas around the house or stable, for disinfecting discharges from the sick room, and in numerous other ways. It tends to harden skins and render them brittle and is, therefore, not suited for the disinfection of furs, but ordinary fabrics are not injured and it usually has little effect on colors.

Advantages and Disadvantages of Formaldehyde

The advantages of formaldehyde may be summarized as follows:

It is a powerful germicide.
Its action is not hindered greatly by albuminous substances or organic matter.
It is relatively not very poisonous.
It is not injurious to delicate fabrics, to paint, or to metals. (Prolonged contact will affect iron but not other metals.)
It is the only known gaseous disinfectant which can be used effectively and safely in households.

The disadvantages of formaldehyde are as follows:

The gas has a strong tendency to condense in cold weather, and it is not reliable as a disinfectant when the temperature of the air is much below 65° F.

It has a very penetrating odor, and the gas is irritating to the eyes and nose. Persons working with this gas should avoid any exposure to the gas.
To accomplish disinfection by the gas a long period of exposure is necessary and considerable work is required in the proper sealing of rooms which are to be disinfected.

CARBOLIC ACID (PHENOL)

The term "carbolic acid" has been rather loosely employed to designate a variety of substances which, though related chemically, are yet very different in their disinfecting properties. The true carbolic acid, or phenol, as it is more properly termed, when in a pure state is solid at ordinary temperatures and when freed of water crystallizes in long white needles. Owing to their property of absorbing water from the air the crystals are likely to form a solid cake in bottles and other containers. For this reason carbolic acid is usually dispensed from drug stores in a liquid form prepared by adding 1 part of water to 9 parts of the crystals. The pure carbolic acid is not well suited for disinfection on a large scale on account of its cost. It is also not so powerful as other disinfectants that may be obtained at a smaller cost.

A 5-percent solution of pure carbolic acid is a very satisfactory disinfectant for sputum or for discharges from the sick room, and a 2-percent solution for disinfecting the hands. Fabrics may be disinfected by immersion in a 5-percent solution for 1 hour. Carbolic acid does not have the power of killing the germs of certain diseases, such as smallpox and hog cholera, or the spores of anthrax and tetanus (lockjaw), but for most of the ordinary bacteria it is very effective. Large surfaces are best treated by spraying with a 5-percent solution. Neither carbolic acid nor other related disinfectants, such as crude carbolic acid, and cresol, are suitable for use in refrigerators or compartments where foods are stored nor in barns where dairy cows are kept, for the reason that all food products tend to take up carbolic

acid from the air and acquire a disagreeable taste and odor that renders them unfit for food.

It should be borne in mind that carbolic acid is one of the most virulent of poisons, when taken internally, and that it also causes serious burns when it comes in contact with the skin and eyes even in small quantities. Not only is it dangerous to leave around the house in concentrated form, but solutions greater than 2 percent are absorptive through the skin and dangerous. Persons using sprays containing 5 percent or more should take special precautions to protect the face.

Advantages and Disadvantages of Carbolic Acid (Phenol)

The advantages of carbolic acid are:

It is reasonably effective for destroying most of the common bacteria.
Its action is not greatly hindered by organic matter.
In a 5-percent solution it does not materially injure metals or fabrics after contact for 1 hour or less.
It is readily available at all drug stores.

The disadvantages are:

It is not effective against all forms of bacteria.
It is expensive.
It is very poisonous.
The strong odor is absorbed by foods.

CRESOL

Cresol is found on the market in varying degrees of purity. It is known also under a variety of names, such as tricresol, cresylic acid, liquid carbolic acid, and straw-colored carbolic acid. It is a clear, oily liquid and varies in color from light straw to a rather deep reddish brown. It has a strong odor resembling that of pure carbolic acid, and, like carbolic acid, is very corrosive when in concentrated form.

The cresol of commerce consists of a mixture of closely related bodies, all of which are superior to pure carbolic acid as disinfectants. It differs from "crude carbolic acid" in being practically free of coal-tar oils. Commercial grades usually contain from 90 to 98 percent of cresylic acid or tar acids, and they may be purchased under guaranty of a definite degree of purity. Grades which contain less than 90 percent of cresylic acid are not so desirable as those of greater purity, for coal-tar oils, generally found in the less pure grades, interfere with the solution of the cresol in water. Under ordinary market conditions cresol is relatively cheap and therefore well-suited to the disinfection of cars, barns, and yards (fig. 1). Cresol may be used in the same way as pure carbolic acid, though it is considerably more powerful as a disinfectant and is therefore employed in a weaker solution. Roughly a 2-percent solution of cresol may be regarded as equivalent to a 5-percent solution of pure carbolic acid.

In preparing solutions of cresol, allowance should be made for the impurities. Cresol is not readily soluble in water; therefore warm water should be used in making solutions and care should be taken to see that all cresol is dissolved before the disinfectant is used. Although cresol is a more effective disinfectant than carbolic acid, its difficult solubility is a rather serious drawback; therefore, compounds of cresol

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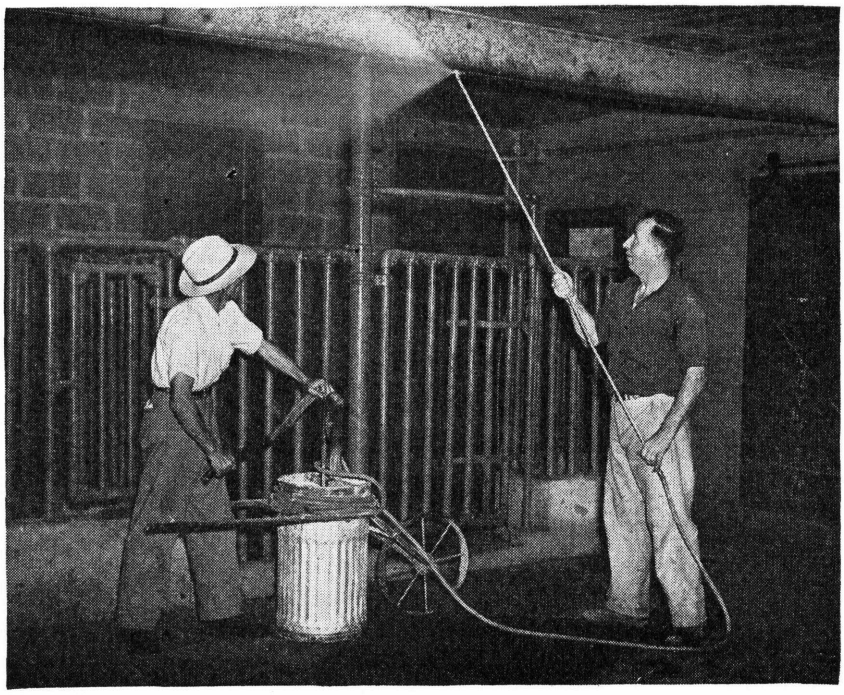

FIGURE 1.—Hand-operated spray suitable for disinfecting interior of stable.

with soap, which are readily soluble, are better than pure cresol for household and farm use. Many mixtures of cresol with soap are on the market under a variety of names.

Cresol is very poisonous, though less so than pure carbolic acid. Use the same precautions as for carbolic acid.

COMPOUND SOLUTION OF CRESOL

A soap solution of cresol, known as the compound solution of cresol, is described in the United States Pharmacopœia (U. S. P. XI, Liquor Cresolis Saponatus) and may be obtained at drug stores. It is a mixture of cresol with a soap made of linseed oil, potash, and soda. This compound solution of cresol is a thick, clear, brown fluid, that mixes readily with soft water in all proportions to form a clear, soapy solution. It does not mix well with hard water because the mineral salts in the hard water cause the soap to break up and separate into sticky masses. Compound solution of cresol is used in a 2- or 3-percent solution.

A very efficient substitute for the compound solution of cresol may be made from U. S. P. cresol by mixing it with ordinary green soap, which is purchasable at all drug stores. The green soap is dissolved directly in the cresol, equal parts of cresol and green soap by weight being used. The cresol is warmed and the soap stirred in until it is thoroughly dissolved.

Substitutes for compound solution of cresol, commonly known as cresylic disinfectants, are prepared and sold by companies dealing in disinfectants. The concentrated disinfectant when purchased already prepared should, if of good quality, be entirely homogeneous in composition. It should be readily and completely soluble in cold, distilled water, and the solution should be practically clear and contain no globules of undissolved oil or cresol. The United States Bureau of Animal Industry requires compounds of this nature, which are to be used in the official disinfection of cars, boats, and stockyards, to conform to very definite standards of composition and solubility. For official use a permitted cresylic disinfectant is usually diluted in the proportion of 4 ounces in 1 gallon of water.

Advantages and Disadvantages of Compound Solution of Cresol

The advantages are:

Weight for weight it is much more efficient and is cheaper than pure carbolic acid.
It is effective against hog cholera, whereas pure carbolic acid is ineffective.
It is very readily soluble.
Its soapy character permits good contact with greasy surfaces.

The disadvantages are:

It cannot be used in or near compartments where foods are kept because of its odor.
It does not mix well with hard water.

It is poisonous, though much less so than carbolic acid. However, the same precautions should be taken with it that are taken for carbolic acid.

CRUDE CARBOLIC ACID

Crude carbolic acid is a dark, oily fluid that is obtained during the distillation of coal tar, and usually contains little or no true carbolic acid. It has been widely used in this country as a household and farm disinfectant. Essentially, crude carbolic acid is a mixture of oils and "tar acids."

There is little to be said in favor of the use of crude carbolic acid as a disinfectant. Its composition is generally uncertain, and it possesses no advantages over other disinfectants, which, considering their power and their ready availability, are to be preferred.

SODIUM ORTHOPHENYLPHENATE

A substance known as sodium orthophenylphenate has proved to be a valuable disinfectant and, like saponated solution of cresol, is effective against the germs of tuberculosis. It has an advantage over cresylic disinfectant in being free from objectionable odor. It is readily soluble in water and is in the form of grayish, brownish, or white powder which must necessarily be kept in a close container in order to prevent deterioration. It is not highly poisonous. As the solution is not effective at a low temperature, it becomes necessary to apply it hot, in order to insure satisfactory results. Some power sprayers have equipment for heating the mixture (fig. 2). Sodium orthophenylphenate preparations under specific named brands are permitted in

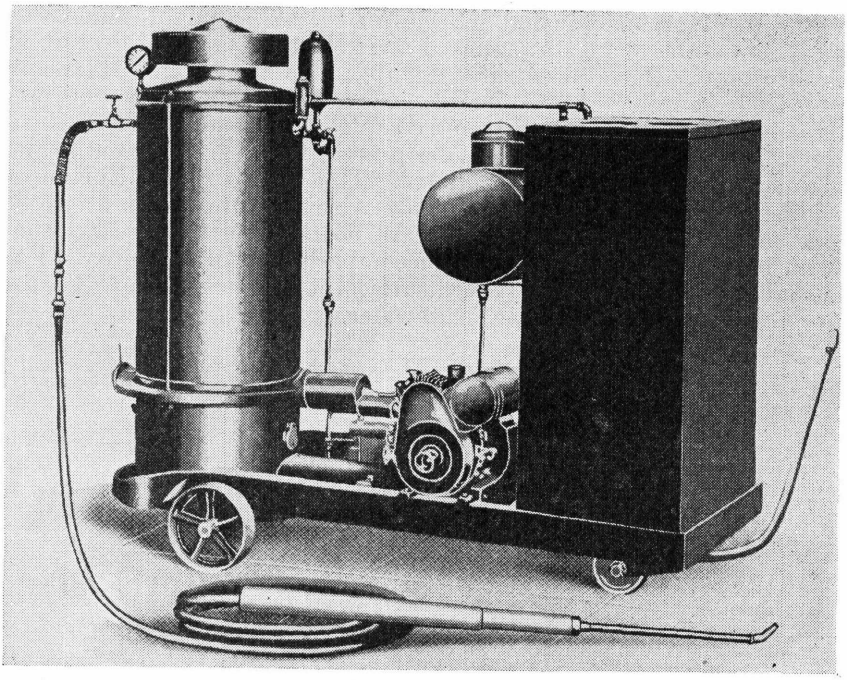

FIGURE 2.—Power equipment suitable for extensive disinfection. It contains an oil-burning device for heating the disinfectant and an engine for compressing air to operate the spray.

official disinfection in tuberculosis-eradication work. It is used in a 1-percent water solution.

EMULSIFIED COAL-TAR DISINFECTANTS

The emulsified coal-tar disinfectants are found widely distributed on the market and are sold in cans or bottles of different sizes under a great variety of trade names. They are prepared from coal-tar products and consist of coal-tar oils and tar acids with soap. The product as purchased is a very dark, thick fluid, which should be of uniform consistency throughout. When it is mixed with water a milky emulsion is formed.

The disinfecting power of these products varies. Since there is no trustworthy method of determining their relative values by chemical analysis, they are compared by laboratory tests on typhoid fever germs. They are tested along with carbolic acid (phenol), and their values in comparison with it are expressed in the form of a "phenol coefficient." Since these coal-tar-emulsion disinfectants vary so much in disinfecting value, it is advisable to use only those that have a guaranteed phenol coefficient. However, since phenol coefficients are determined under laboratory conditions that are likely to differ from conditions in practical disinfection, the coefficient often does not accurately indicate the relative values of disinfectants in actual use.

It should be borne in mind that the phenol coefficients are determined in the absence of organic matter. Most disinfectants, however, are

actually applied in the presence of organic matter (manure, blood, and dirt) which impairs the efficiency of the disinfectants against bacteria. The emulsified disinfectants suffer much greater loss in efficiency than solutions of phenol so that under the conditions of practical use the phenol coefficient does not accurately indicate the relative values. In general, the higher the coefficient the greater the allowance that should be made for the adverse effect of organic matter. In the presence of organic matter the emulsified disinfectants may usually be effectively employed at a concentration twice as great as would be indicated by the coefficient.

In general these emulsified coal-tar disinfectants have the same uses and properties as carbolic acid and compound solution of cresol, though they are less poisonous than either. However, the same precautions should be taken in handling them.

LIME

Ordinary quicklime is one of the best and cheapest of disinfectants. It is not commonly applied in the form of quicklime, but in the form of a thick mixture with water known as "milk of lime." The lime is first slaked by adding 1 pint of water to 2 pounds of quicklime. Considerable heat is generated by this mixture, owing to a chemical union of the lime and the water, which forms the hydrate of lime, or water-slaked lime. The development of heat and the crumbling of the hard lumps of quicklime are indications that the lime is of good quality and that it will make a satisfactory milk of lime.

A word of caution should be added for the benefit of those who are not familiar with the handling of lime. Lime dust is irritating to the skin and eyes. Also when water comes in contact with lumps they sometimes explode, thus endangering the eyes of anyone doing the mixing. Some type of protection such as goggles is advisable.

Milk of lime is obtained by adding 4 volumes of water to 1 of the slaked lime and mixing thoroughly. Lime that has been exposed to the air for a long time becomes air slaked; that is, it takes up moisture and carbonic acid from the air and is converted into carbonate of lime, which is the same as marble and almost totally worthless as a disinfectant. After quicklime has been slaked with water, the slaked lime and any stock solution of milk of lime that may have been prepared should be kept in tightly closed containers to prevent deterioration, which will result from the action of the air. Whitewash is prepared by adding water to milk of lime until a mixture of suitable density is obtained.

Quicklime may be scattered about yards and lots, and the milk of lime is a good disinfectant for sickroom discharges. It should be added to urine or excreta in liberal quantity and allowed to remain in contact with these discharges for 2 hours before they are disposed of. Whitewashing of fences, pens, and the interior of outhouses serves to render them more sanitary as well as more attractive in appearance. Lime is well suited for use about dairy barns on account of the lack of any odor. It is preferable to chlorinated lime for that reason.

The advantages of lime as a disinfectant consist in its ready availability and cheapness. It is not effective, however, against the spores

of germs that cause anthrax and lockjaw or against the germs of tuberculosis.

The following formulas for special whitewashes (from Farmers' Bulletin 1452, Painting on the Farm) may be found useful:

Whitewash No. 1 (for sheds, etc.)—Carefully slake half a bushel (38 pounds) of good quicklime; strain the paste, while still thick, through wire fly screen and add it to a solution made by dissolving 15 pounds of common salt in 7½ gallons of water, mixing thoroughly. Thin with more water.

Whitewash No. 2 (for sheds, etc.).—Carefully slake half a bushel (38 pounds) of good quicklime; strain the paste, while still thick, through wire fly screen and add about 4 gallons of hot water. While stirring vigorously pour into the lime mixture a solution made by first dissolving 12 pounds of salt and 6 ounces of alum in about 4 gallons of hot water and then adding 1 quart of molasses. Thin with water.

LYE

Ordinary lye usually contains about 94 percent of a chemical known as sodium hydroxide, which is a very effective disinfectant. It is effective against the viruses of foot-and-mouth disease and hog cholera and the germs of fowl cholera and pullorum disease of young chicks. In strong solutions it is effective against the spores of anthrax but not against the germs of tuberculosis. It is usually employed as a 2-percent solution in water, but for disinfection against anthrax it is necessary to use a 5-percent solution. A 2-percent solution may be prepared by adding 1 pound of lye to 5½ gallons of water. In cases where lime is not objectionable, the addition of 2½ pounds of water-slaked (not air-slaked) lime to the 5½ gallons of lye solution to form a whitewash will increase the effectiveness of the solution by preventing the transformation of the sodium hydroxide into a carbonate. A whitewash made in this way should not be applied to materials that are injured by lye.

Concentrated lye is a caustic poison. Care should be taken to avoid getting any of it into the eyes and breathing in any of the fine dust that may arise while handling the dry material. A dust respirator having full face protection would be an additional safeguard. Solutions should be so disposed of as to prevent injury to livestock.

Solutions of lye are injurious to painted or varnished surfaces and to woolen or silk fabrics if allowed to remain in contact with them for a considerable period of time. Since they do not injure bare wood, earthenware, enamelware, or any of the common metals except aluminum, they may be kept in containers made of these materials. Since exposure to the air soon converts sodium hydroxide to the relatively inactive sodium carbonate, containers should be kept tightly covered.

VARIOUS CHEMICAL COMPOUNDS

Sodium carbonate and trisodium phosphate are used chiefly as cleansing agents, but they also have appreciable disinfecting value. If they are to be used in solution for disinfecting purposes at ordinary temperatures it is advisable to add 0.5 percent of sodium hydroxide, but if the solutions are to be used hot this will not be necessary. Sodium carbonate is obtainable in the form of washing soda, soda crystals, and also as soda ash. Washing soda should be used in 6-percent and soda ash

in 2-percent solution. Trisodium phosphate can be obtained as tribasic phosphate of soda, which should be used in a 2.5-percent solution.

The various inorganic compounds of mercury, especially the bichloride (corrosive sublimate), are known to be powerful disinfectants. They are not suitable for farm use, however, on account of the danger to the farm family and to livestock as well as their relatively high cost. From time to time various compounds of copper, arsenic, or zinc have been recommended as germicides, but they all have relatively little germicidal value. Sulfate of copper (blue vitriol), however, is extremely effective against algae, and since algae often cause unpleasant odors or tastes in drinking water, copper sulfate is sometimes added to water to check or destroy their growth.

As all of these compounds are poisonous, they should be used only with care.

CHLORINE DISINFECTANTS

Chlorine gas as a disinfectant is almost exclusively used for the treatment of water supplies or sewage. Some of its compounds, however, are widely used for disinfection on the farm.

CHLORINATED LIME

Chlorinated lime is commonly known also as "bleaching powder" or "chloride of lime." It is a white powder that gives off the disagreeable odor of chlorine. It should be kept in hermetically sealed containers, as exposure to the air causes it to deteriorate rapidly. The efficacy of chlorinated lime is largely dependent upon the quantity of available chlorine that it contains. The United States Pharmacopœia requires that at least 30 percent of chlorine should be present in available form.

In preparing solutions of chlorinated lime, it should be kept in mind that the substance is poisonous and gives off chlorine gas. The operation should therefore be performed in a well-ventilated room or out of doors.

Although chlorinated lime is a very powerful disinfectant, its potency is immediately and greatly reduced when it is brought into contact with organic matter. This is because the available chlorine combines quickly with the organic matter and is thus diverted from its desired action upon the germs. In applying chlorinated lime to the disinfection of sickroom discharges, manure, etc., it is important to add it in considerable excess so as to make allowance for the chlorine that will be used up by the organic matter. Besides being a good disinfectant, chlorinated lime is a powerful deodorant.

Chlorinated lime is only partly soluble; therefore in preparing it for use it is well first to rub it up well with a little water so as to break up the lumps, finally diluting to the desired volume. For general household and farm use, 6 ounces of chlorinated lime are mixed with 1 gallon of water.

OTHER CHLORINE DISINFECTANTS

Besides chlorinated lime, other similar chlorine compounds have come into more or less general use in recent years. Sodium hypochlorite, which is usually sold in solution and under various proprietary names, has been extensively used to disinfect dairy equipment,

such as milk cans and bottles and conveying pipes in creameries. This compound, in the concentrations usually employed, is effective when applied to perfectly clean surfaces, but, like chlorinated lime, its efficiency is largely reduced in the presence of organic matter.

The uses to which chlorine disinfectants may be put are restricted because of corrosive action and their odor. They are powerful bleaching agents and corrode metals. The odor is apt to be absorbed by meat, milk, and other food, and for these reasons the use of chlorine disinfectants is not recommended about ice boxes, cellars, or compartments where food is stored or in dairy barns. The chlorine disinfectants are not effective against the germs of tuberculosis.

IODINE

Iodine in solution is extensively used for skin disinfection, and it remains the standard for this purpose although there are many proprietary preparations containing organic compounds of mercury or silver that are widely advertised. Tincture of iodine (not more than 7 percent) is the solution most generally employed. Although complete sterilization of the skin by any disinfectant is almost impossible, the application of tincture of iodine for treatment of superficial wounds or for preparing the site for an operation does serve to reduce the number of disease germs to a minimum. Since dirt interferes with the germicidal efficiency of iodine, the skin should be cleaned as well as possible before the solution is applied. Avoid bandaging until skin is dry.

ALCOHOL

Grain alcohol has been used more or less as a disinfectant, and laboratory tests have shown that it is effective against the less resistant disease germs, such as those that cause typhoid fever. Absolute alcohol or solutions containing less than 50 percent of alcohol have comparatively little germicidal value. The most effective solutions are those containing about 70 percent of alcohol—the amount usually contained in "rubbing" alcohol.

BORIC AND ACETIC ACIDS

Boric acid is a very feeble germicide, although it is often used in solution as an application for the eyes and other sensitive parts of the body. It is usually used in a saturated water solution, prepared by dissolving it in boiling water and then allowing it to cool and applying the resulting solution. Acetic acid is a more effective germicide, and the amount usually found in full-strength vinegar (usually about 5 percent) is sufficient to kill some of the less resistant disease germs. It is a stronger acid than boric and too irritating for application to the eyes or other sensitive parts of the body. Vinegar is sometimes used in the treatment of local infections or of skin diseases.

SOAPS

Soaps have some germicidal power, especially when used with hot water, but this power is rather limited. Cleaning with soap and hot water kills some of the less resistant disease germs but the effect is largely mechanical through the removal of dirt and infective material.

Of the soaps commercially available those prepared exclusively from coconut oil, such as so-called salt-water soap, usually have greater disinfecting value. Medicated soaps, in general, have little disinfecting power and cannot be relied upon to destroy resistant organisms.

DETAILS OF DISINFECTION

The general procedure of disinfection is very much the same for all types of farm buildings, whether they are stables, dairy barns, or poultry houses. However, special emphasis is given in this publication to the use of disinfectants in stables and dairy barns.

In the practical work of disinfection there are three essentials:

(1) A preparation of the building that will facilitate reaching organisms of disease.
(2) A disinfectant which upon contact can be depended on to destroy such organisms.
(3) A method of applying the disinfectant that will assure the most thorough contact with the bacteria.

PREPARATION OF BUILDING

Before beginning the use of a disinfectant it is essential that certain preliminary work be done in and about the stable that is to be treated. The various surfaces, such as ceiling, walls, partitions, floors, etc., should be swept free of cobwebs and dust. Any accumulation of filth should be removed by scraping and scrubbing with a wire brush or other stiff brush and warm water with a liberal quantity of washing soda. In some cases the woodwork may have become softened and so porous as to be a good medium for the absorption of disease germs. Such woodwork should be removed, burned, and replaced with new material.

All refuse, manure, etc., from stable and barnyard should be removed to a place inaccessible to livestock and, if possible, should be burned or thoroughly mixed with a solution of chloride of lime in the proportion of 6 ounces to 1 gallon of water. If the floor is of earth, it will doubtless have become stained with urine and contaminated to a depth of several inches. In such cases 4 inches or more of the surface soil should be removed and treated as suggested above for refuse and manure. All earth removed should be replaced with soil from an uncontaminated source, or better, a new floor of concrete may be laid, this being the most durable and sanitary material for the purpose.

METHOD OF APPLICATION

The efficacy and economy of the work will depend in great measure on the method of applying the disinfectant. Economy requires that the disinfecting solution be applied rapidly. Efficiency requires not only that it be spread in such manner as to cover the entire surface requiring disinfection, but that sufficient quantity and force be used to drive the solution into all cracks and crevices.

If a very limited surface is to be treated, as, for example, one stall, it may be possible to apply the disinfectant in a satisfactory manner by means of a whitewash brush. In all cases, however, the best method of applying the disinfectant and the limewash is by means of a strong spray pump. Such a pump should be equipped with not less than

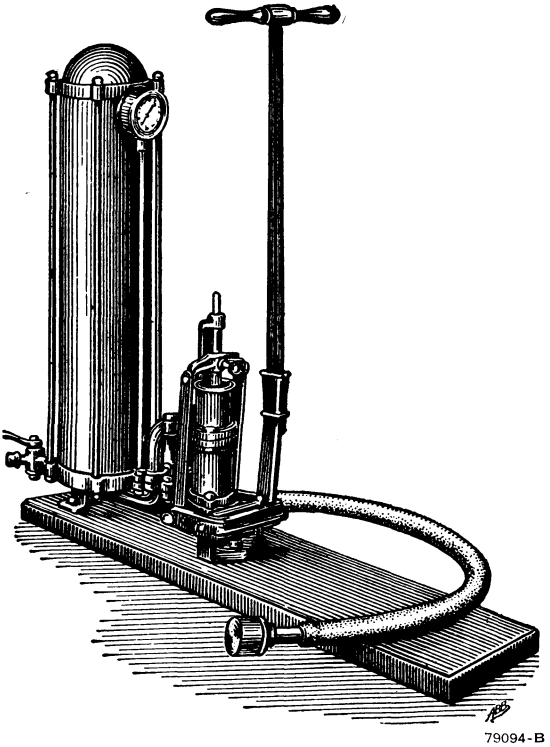

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Figure 3.—Double-acting sprayer with air chamber.

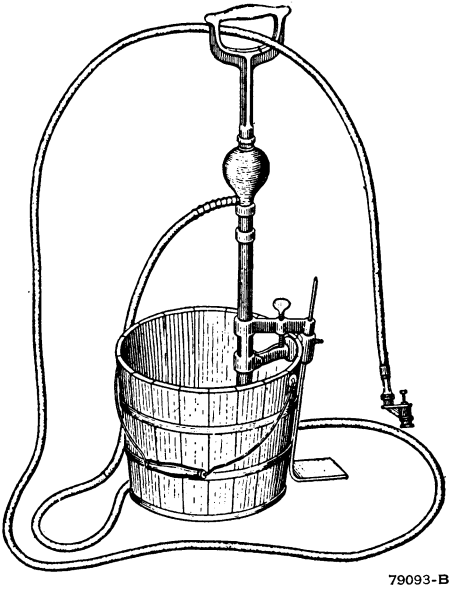

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Figure 4.—Small spray pump suitable for disinfecting stables. This type is sometimes called a stirrup pump.

15 feet of hose, to which may be attached a 5-foot section of iron pipe of the same caliber as the hose. With a spraying nozzle at the end of the pipe, the operator will be able to work with the greatest possible dispatch and the least possible inconvenience. Good types of hand-operated apparatus are shown in figures 3 and 4. Figure 3 shows an outfit that requires two men to operate. Figure 4 illustrates equipment sometimes called a stirrup pump that may be operated by one man.

The entire interior of the stable should be saturated with the disinfectant. Special attention should be given to the feeding troughs and drains. After the disinfectant has dried, the surface may be sprayed with whitewash, provided this is desired. When the work has been completed it will be advisable to open all doors and windows of the building to admit air and light.

The metal parts of any pump or other equipment used in spraying disinfectants, especially a lye solution, should be carefully cleaned and oiled after use.

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